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Free Response: 5 questions, 55 minutes

1. **The casino game of chuck-a-luck seems quite simple and that it would be a pretty good bet. In this game, three dice are rolled (usually inside a wire cage). You can bet a set amount, let's say $5, on a specific number 1-6. You win the amount of your bet for each appearance of your number on the dice. If the number does not appear, you lose your bet. For example, let's say you bet $5 on the number 3. If it appears on exactly one die, you win $5 (and keep your bet) with probability 75/216. If it appears on exactly two dice, you win $10 (and keep your bet) with probability 15/216. If it appears on all three dice, you win $15 (and keep your bet) with probability 1/216. If it appears on none of the dice, you lose your original $5 bet. Construct the probability distribution for chuck-a-luck and determine your expected winnings on a $5 bet.** (20 points)

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Answer

Amount won	-5	5	10	15
p	125/216	75/216	15/216	1/216

Exp. Value = (125/216)(-5) + (75/216)(5) +(15/216)(10) + (1/216)(15) = -.39
You will lose about 39¢, on average, for each $5 bet.

2. The data below are the results of two 25-point quizzes in an AP Statistics class.

Q#1	**Q#2**
23	21
18	19
21	12
24	22
23	23
23	20
20	9
21	13
20	23
23	13
20	4
20	10
20	17
20	18
*22	*18
24	13
20	24
22	24
24	23
23	23

A. Compare the performances on the two quizzes. Which one do you think had better scores overall, and why? Use both analytical and graphical approaches in your answer. (10 points)

Answer
analytical:
for quiz #1, $\bar{x}$ = 21.55, s = 1.761, med = 21.5
for quiz #2, $\bar{x}$ = 17.45, s = 5.844, med = 18.5.

They are both 25-point quizzes, so the higher mean and median on quiz #1, combined with less variability, indicates that performance was higher on the first test.

Graphical : Here's one way. The boxplot shows that median of first test is near the upper quartile of the second.

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Could also use back-to-back stemplots, dotplots, etc. to demonstrate this graphically.

B. Note that one student's scores are marked with an asterisk (*). Did that student do better on the first test or the second test? Explain. (10 points)

Answer
$z(22) = .26$, $z(18) = .094$. The 22 is slightly more removed from the mean than the 18, so the 22 was relatively, though only slightly, better than the 18.

3. The heights of trees in a large grove are normally distributed with a mean of 85 feet and a standard deviation of 10 feet. Explain your answers and provide a drawing of the probability (area under the curve) for each situation.

A. What is the probability that a tree selected at random is more 100 feet tall? (6 points)

Answer
.0668, must show a drawing

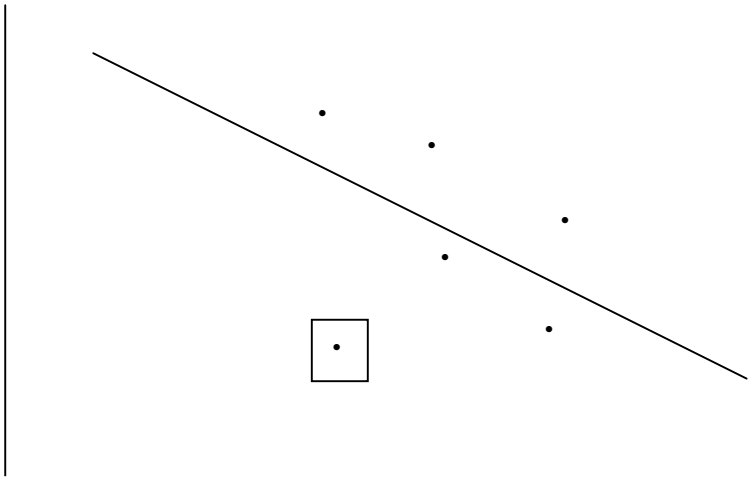
B. What is the percentile rank of a tree that is 80 ft. tall? (6 points)

Answer
30.85, must show a drawing

C. What is the minimum height of a tree that is in the top 10% of heights? (8 points)

Answer
97.8 ft., must show a drawing

4. Consider the following scatterplot and line of best fit**:**



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A. Use the following diagram to explain what is meant by *line of best fit*. (8 points)

Answer
Must argue that the line is, of all possible lines, the one that minimizes the sum of squared errors (residuals) from the line. They should show enough on the drawing that it's clear what they are talking about.

B. Does the point in the box have a positive or a negative residual? Explain. (6 points)

Answer
Residual equals actual value minus predicted value. Since the data point is below the line, the residual must be negative.

C. Is the point in the box an outlier or an influential point? Explain. (6 points)

Answer
It's an outlier, since it has a large residual relative to the other points. An influential point can be a point with a large residual, but it's usually removed from the data in an *x*-direction rather than the *y*-direction.

5. You believe that eating an apple a day is healthy and want to design an experiment to find out. You have available 40 volunteers (22 men and 18 women) from a four-year college, all between the ages of 18 and 22. Design an experiment to help you determine if this practice is healthy or not, and explain, in terms of the important principles of experimental design, why you chose the design you did. (20 points)

Answer
Different answers are possible. The important thing is that it correctly follows the principals of experimental design and that students somehow justify the main elements of the design in terms of how they will make the results more valid.

One concern might be that men and women would have different health reactions to eating an apple a day. So, you would first block on men and women. This would control for the variability between men and women and allow a more precise study of differences between the sexes.

Within the group of men, you would randomly assign 11 men to eat an apple a day and the other 11 to, say, eat no more that one apple per week. You would randomly divide the 18 women similarly. The randomization is important here because it controls for experimenter bias in the selection process, and it should help control for lurking variables such as pre-existing health differences. The group that eats no more than one apple per week is a control group, which also helps control for lurking variables. Replication (which helps control for random variability) is achieved in this experiment by assigning the same treatments to 11 of the men and 9 of the women.

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Let several months pass and compare the two groups within the block of men and the block of women to see if there are important health differences between the two groups (we are assuming that randomization would have taken care of any pre-existing health differences).

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